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LOUIS BARR and ROLAND McBRIDE

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# Surface-to-Bottom Pot Fishing for Pandalid Shrimp

By

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## ABSTRACT

Baited shrimp pots were used to study the seasonal and diel changes in vertical distributions of several species of pandalid shrimp (primarily Pandalus borealis, P. goniurus, and P. hypsinotus) in Kachemak Bay, Alaska. This method has good potential for sampling shrimp populations in untrawlable areas.

## INTRODUCTION

Shrimp of the family Pandalidae are generally captured on, or immediately above, the bottom by trawling and pot fishing. Trawling, which is the more common method, has been used in Europe (Hjort and Ruud, 1938; Allen, 1963) and on North America's east coast (Scattergood, 1952; Dow, 1963) and west coast (Hynes, 1929; Harry, 1964). The other common method, pot fishing, has been used in the British Isles (Davis, 1958), Washington State (Westley, personal communication), British Columbia (Butler, 1964), and Alaska (Ellson and Livingstone, 1952; Ronholt, 1963; Harry, 1964). Additional methods, used less frequently, include: bag (or hoop) nets, which were fished for Pandalus borealis in Dram's Fjord, Norway, during the 1800's (Hjort and Ruud, 1938); kype (or hose) nets, a type of fixed gear, which was occasionally used to take P. montagui in British estuaries (Matthews, 1934--cited by Mistakidis, 1957); and beach seines,[1] which were used in the early shrimp fishery of Puget Sound (Smith, 1937).

Pandalid shrimp have been caught occasionally at midwater depths. For example, they were taken incidentally during exploratory fishing with midwater trawls (Tegelberg and Smith, 1957; Aron, 1959; Rathjen and Fahlen, 1962). Nansen (1924--cited by Hjort and Ruud, 1938) reported taking shrimp (presumably P. borealis) by midwater fishing of bag nets in Denmark Strait.

We have been studying the life history, behavior, and ecology of pandalid shrimp in Kachemak Bay, Alaska, since 1963. We have used pots and bottom trawls to collect the shrimp. Incidental visual observations and several sets with pots at midwater and near the surface showed that many shrimp leave the bottom, especially during the night. In addition, we found that some species could be captured in far greater quantities in pots set off the bottom than on the bottom. Thus, the studies reported in the literature and our own limited observations showed a need for a method to investigate the vertical distribution of shrimp.

In this paper we describe a method of pot fishing that was developed to study the seasonal and diel vertical distributions of pandalid shrimp. In addition, we point out the value of this method in studies of populations of shrimp in untrawlable areas.

## EQUIPMENT AND FISHING METHODS

The basic unit of gear was five pots spaced at intervals from the bottom to the surface along a vertically suspended line (fig. 1). An anchor was attached to one end of the line, and a surface buoy and a trailer buoy were attached to the other. Heavy nylon twine loops for attaching the pots were tied to the line in the following positions: (1) 1 foot (0.3 m.) above the bottom end, (2) one-quarter of the distance from the bottom to the surface, (3) one-half of the distance from the bottom to the surface, (4) three-quarters of the distance from the bottom to the surface, and (5) 2 feet (0.6 m.) below the surface. A loop for a subsurface buoy was tied 2 feet (0.6 m.) above the three-quarter point between pots 4 and 5 (fig. 1). The length of line was equal to the depth fished.

The anchor was a round lead trolling weight (25 to 50 lb.--11.3 to 22.7 kg.) heavy enough to

[1] It is uncertain whether the beach seines were fished for pandalid or crangonid shrimp.

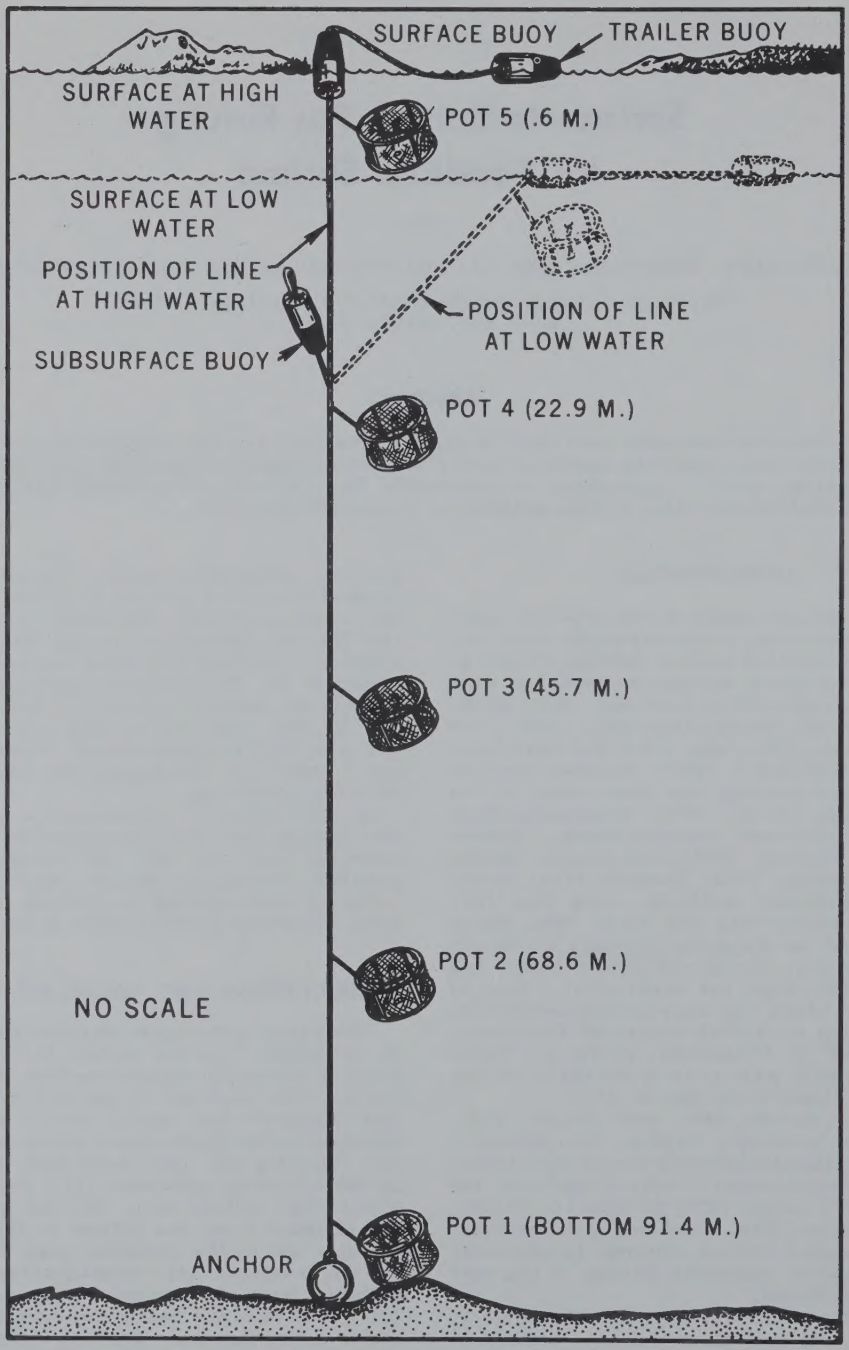



Figure 1.--Diagrammatic illustration (not to scale) of a surface-to-bottom pot set to fish for shrimp, Kachemak Bay, Alaska.

submerge the entire assembly and to prevent it from drifting, even in areas with 1- to 2-knot tidal currents.

Three plastic foam buoys about 14 inches (35.6 cm.) long and 5 inches (12.7 cm.) in diameter were used in each set--a subsurface buoy, a surface buoy, and a trailer buoy. The subsurface buoy held the three midwater pots in position relative to the bottom, and the surface buoy held the top pot in position relative to the surface. The trailer buoy, on a 12-foot (3.7-m.) line attached to the surface buoy, facilitated our recovering the gear.

The pots were built with plastic pipe and covered with fine-woven nylon mesh (fig. 2). They were 22 inches (55.9 cm.) in diameter and 14 inches (35.6 cm.) high and had four funnel-shaped entrances. A line clip fastened to the frame was used to attach the pot to the nylon loop on the line. The pots weighed 2.2 pounds (1.0 kg.) and had a slight tendency to sink in sea water. Chopped herring was put in a bait box suspended in the pot. Details of the materials and construction of the pots are described by McBride and Barr (1967).

The anchor, bottom pot, and surface and trailer buoys were attached to the line before a set was started. As the line was dropped, the resistance of the pots in the water slowed the rate of descent so that the rest of the pots and the subsurface buoy could be attached easily.

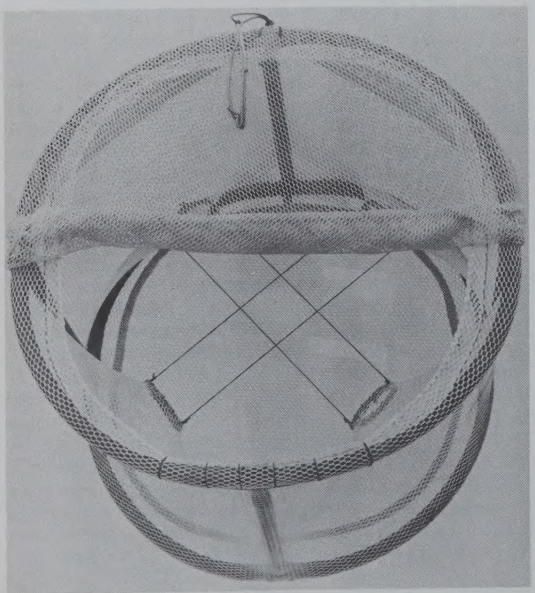


Figure 2.--Pot used in surface-to-bottom string of pots set to fish for shrimp, Kachemak Bay, Alaska.

The string of pots was retrieved in three steps. First the trailer buoy and the surface buoy were pulled onto the deck by hand. The line was then passed over an open block (suspended over the side by a davit--fig. 3) and around a hydraulic windlass. The rest of the line and the attached gear were then pulled up by the windlass. One man unsnapped the pots and the subsurface buoy as they appeared, and another coiled the line.

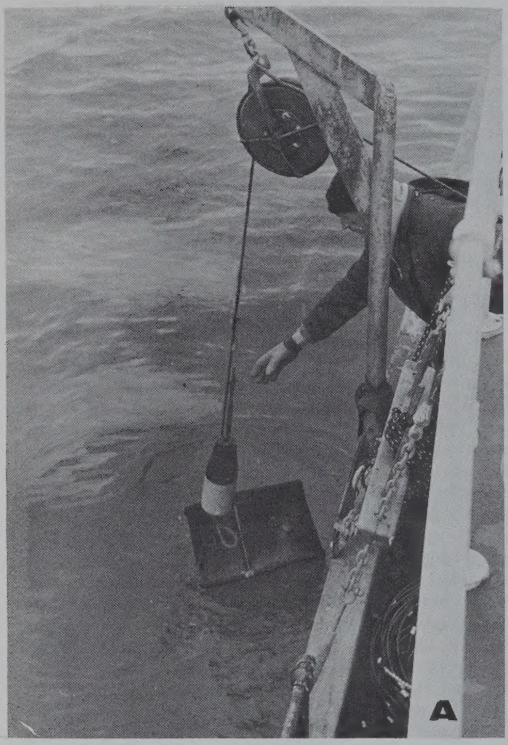
## EFFECTS OF TIDES ON OPERATION OF GEAR

When a vertical series of shrimp pots is fished where tides are present, it is impossible to maintain constant distances from each pot to both the surface and the bottom. The average diurnal tide range in Kachemak Bay is 18.2 feet (5.5 m.) (U.S. Coast and Geodetic Survey, 1966). We designed the surface-to-bottom pot fishing gear to absorb the effects of this change in water depth in the upper quarter of the line. The bottom pot was held on bottom by the anchor, and the three midwater pots were maintained at nearly constant positions relative to the bottom by the lift of the subsurface buoy immediately above the fourth pot. The surface pot was maintained in its position relative to the surface by the surface buoy (the surface buoy was occasionally submerged during high-water periods), but the distance from the bottom and from the other pots changed as the depth of the water fluctuated. It was especially important to maintain a constant distance between the bottom pot and the next pot above because it is here that the greatest differences occurred in species composition of the catch (fig. 4).

## EFFECTIVENESS OF THE TECHNIQUE

Sampling in Kachemak Bay with all gear revealed the presence of many species. The most common and abundant species of the family Pandalidae were Pandalus borealis (pink shrimp), P. goniurus (humpy shrimp), and P. hypsinotus (coonstripe shrimp). P. platyceros (spot shrimp) and Pandalopsis dispar (sidestripe shrimp) occurred less frequently but were abundant at some locations. Pandalus danae and P. stenolepis were taken only occasionally and were never abundant. Several species of the families Hippolytidae and Crangonidae were abundant in most areas of Kachemak Bay.

Surface-to-bottom pot fishing caught most of the species of shrimp known to be present. All species except those in the family



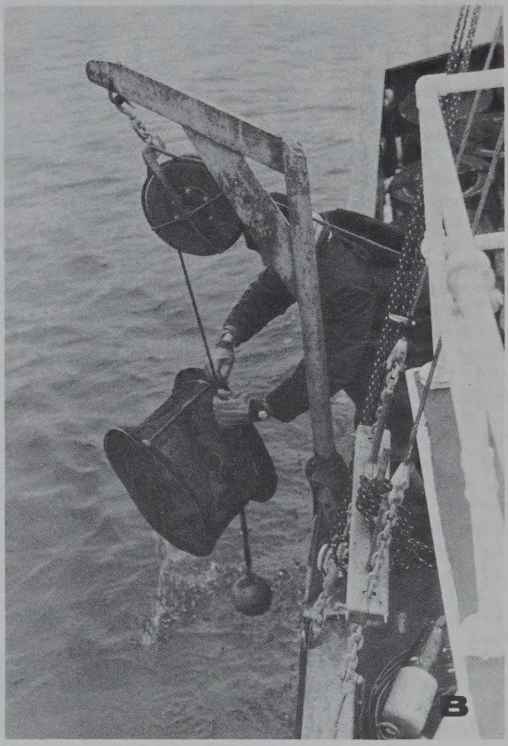



Figure 3.--String of shrimp pots being pulled from water, Kachemak Bay, Alaska. (A) Subsurface buoy and adjacent pot approaching open block; (B) bottom pot and anchor approaching open block; (C) pots being emptied after entire string is retrieved.

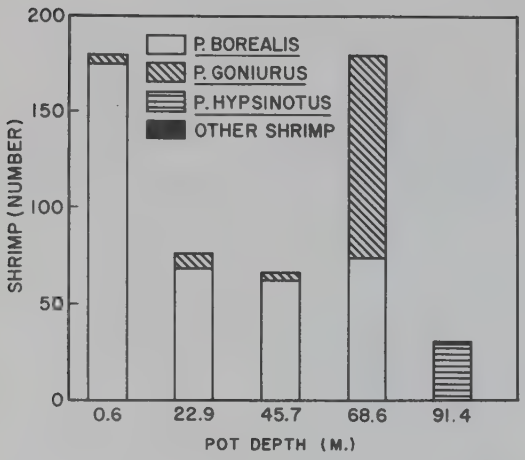



Figure 4.--Species composition of individual pot catches from a surface-to-bottom series of shrimp pots fished 1 day in 300 feet (91.4 m.) of water in Kachemak Bay, Alaska.

Crangonidae and Pandalopsis dispar were readily taken in pots. Although P. dispar and species of Crangonidae were common in trawl catches, no P. dispar and only a few Crangonidae were taken in pots during the 3 years we sampled in Kachemak Bay. Apparently they did not enter baited pots.

The fishing of surface-to-bottom pots was applied in two ways in our shrimp investigations in Kachemak Bay. First, 1-day sets were made at each of three sampling sites twice each month. This sampling provided information on seasonal changes in species composition and size of shrimp by depth and site. Figure 4 illustrates the catch from a typical 1-day set. Second, two strings of pots occasionally were set about 400 feet (121.9 m.) apart in 300 feet (91.4 m.) of water, and each string was pulled and reset (after removing the catch) every 3 hours throughout a 24-hour period. This sampling supplied information on the diel changes in vertical distribution (vertical migration) of shrimp. Catches at various levels showed the progression of the vertical migration. Comparison of the catches in the two strings for each 3-hour period indicated the variation between sampling areas in the abundance of shrimp at particular levels. Figure 5 illustrates the type of data obtained for one string of pots during one set of this type (catches of only one species, Pandalus borealis, are shown).

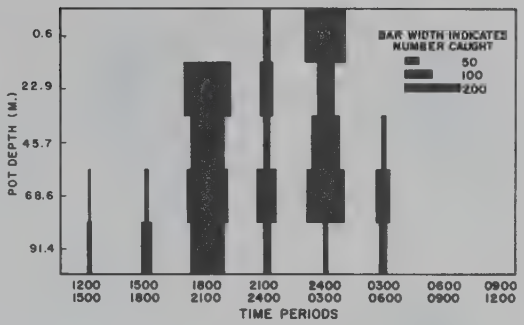



Figure 5.--Catches of Pandalus borealis for 3-hour fishing periods throughout a 24-hour period in pots of a surface-to-bottom set, Kachemak Bay, Alaska, April 16-17, 1966. The set consisted of five pots, one suspended at each of the following approximate depths: 2 feet (0.6 m.) (surface), 75 feet (22.9 m.), 150 feet (45.7 m.), 225 feet (68.6 m.), and 300 feet (91.4 m.) (bottom).

We did not use sets of surface-to-bottom pots specifically for studying shrimp in untrawlable areas, but comparison of catches of shrimp in pots and trawls made the values of this use apparent. The need for a method of studying the shrimp populations in untrawlable areas is indicated by the observation of Hjort and Ruud (1938) that most of our knowledge of shrimp stocks is from trawling, whereas in the same paper they mentioned an apparent increase in shrimp abundance near "the rocky sides of the prawn grounds."

Representative data from catches of shrimp taken by bottom trawling, surface-to-bottom pot fishing, and bottom pot fishing in Kachemak Bay are presented in figure 6. The relative abundance of the species taken in surface-to-bottom pot fishing is nearer that of the trawl catches than is the relative abundance in the catches in bottom pots only. Although the three methods generally take the same species, the trawl and surface-to-bottom pots catch primarily P. borealis, and secondarily P. goniurus, whereas the bottom pots catch mostly P. hypsinotus and species of the family Hippolytidae.

If we assume that the trawl catches are our best indication of the species composition of the shrimp population at the point fished, the surface-to-bottom pot fishing gives a better indication of the species composition than does bottom pot fishing. This difference in the catches of the two methods of pot fishing should be considered in studies of shrimp in untrawlable areas.

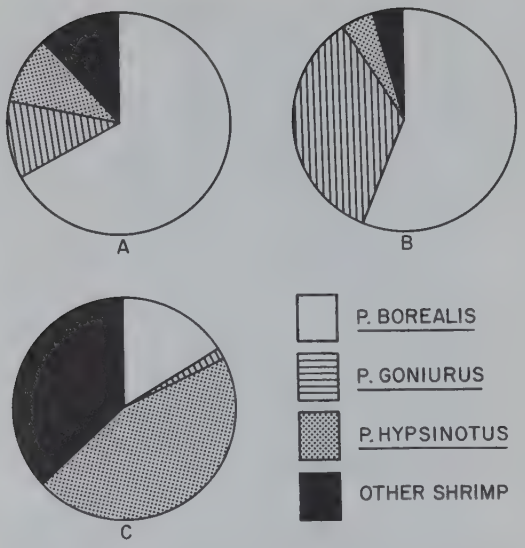



Figure 6.--Relative abundance of species of shrimp taken in (A) bottom trawling, (B) surface-to-bottom pot fishing, and (C) bottom pot fishing, Kachemak Bay, Alaska, April-May 1964.

## ADVANTAGES AND DISADVANTAGES OF POT FISHING

Surface-to-bottom pot fishing proved to be a suitable method for sampling pandalid shrimp at various depths both on and off the bottom in Kachemak Bay, Alaska. This type of gear is especially useful in studying the vertical migrations of pandalids because it provides a method of fishing with simultaneous and uniform effort at several vertical levels. In addition, the surface-to-bottom pots offer the best method available for obtaining representative samples of shrimp in untrawlable areas.

The most serious deficiency of this method is that its effectiveness depends on the vulnerability of the shrimp to baited pots. Although most pandalid shrimp entered the pots, though perhaps to varying degrees, one species was not taken by pot fishing. Future work in the field and laboratory, will be necessary to determine the vulnerability of the various species to baited pots.

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